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AP20 Rec'd PCT/PTO 02 AUG 2006Electrically heatable insoleField of Invention

5 [001] The present invention relates to an electrically heatable insole according to the preamble of the main claim.

Background Information

10 [002] A heatable shoe sole is known from DE 39 04 603 A1 which is constructed from a plurality of layers, one layer which serves for generating heat being formed from a conductive plastic material foil with strip conductors deposited thereon. In the central foot region of the sole, a cold conductor switch element is provided on the underside of the heating foil, said switch element registering the actual temperature present and switching on the heating at a predetermined temperature and, upon reaching a further predetermined temperature, switching it off again. In the region of the heel, a rechargeable battery with an inductive charging coil and rectifier is provided.

Summary of Invention

25 [003] The present ~~object underlying the invention relates is to produce~~ an electrically heatable insole which provides flexible usage options and is simple to operate.

30 ~~[004] The object is achieved according to the invention by the characterising features of the main claim in conjunction with the features of the preamble.~~

35 ~~[005]~~ [004] As a result of the fact that the control circuit disposed in the sole has a remote control device for switching on and off or controlling

the heating process, the heating process can be used by the user in a flexible manner independently of the temperature attained and can be switched off and on simply according to his wishes. By providing a protective circuit for disconnecting the rechargeable battery from the remaining current circuit, too great a heat development is prevented from taking place in the case of a short circuit or the like, which can be dangerous for the user.

{006}[005] In particular, the heating electrode can be actuated by pulsating voltage. The frequency of these impulses is tuned such that in addition the blood circulation is stimulated. Since normal batteries lose power at low temperatures, this type of heating process has a second advantage: the batteries are under load for a short time. Subsequently, they are given a short regeneration phase in which they can recover. This increases the power capacity to a large degree at low temperatures and also extends the lifespan of these cells.

{007}[006] Due to the measures indicated in the sub-claims, advantageous developments and improvements are possible.

{008}[007] It is particularly advantageous that the rechargeable battery is a lithium accumulator since the accumulators are especially flat and withstand the loading by the heel pressure. Preferably, LI ions or LI polymer accumulators can be used since they deliver the necessary power in the case of a smaller, above all flat construction.

{009}[008] The choice of batteries used is of particular importance: on the one hand, these must

have a correspondingly high capacity in order to achieve acceptable heating times and temperatures, on the other hand, they must be small and light in order not to restrict the comfort when moving. This demands a high energy density, such as cannot be achieved for example with conventional nickel accumulators.

~~{010}~~[009] Rechargeable lithium-ion cells have a suitable high energy density. Because of the high energy density, such batteries represent a risk potential however. A short circuit would lead to an explosion of the cells. Furthermore the cells must also be protected from excess currents and total discharge, both events which lead to total destruction of the cells. Only the feature according to the invention of a protective circuit allows sensible use of such cells in a sole.

~~{011}~~[010] Lithium, which already has an extreme reaction chemically with normal atmospheric humidity, must also be protected against mechanical damage (stepping on a nail). Mechanical protection is ensured by a metal cage which surrounds the battery.

~~{012}~~[011] Alternatively, also lithium-ion polymers can be used as batteries. Because of their flexibility, these are particularly suitable for use in a sole. Since dry batteries are of concern here, there is no danger of an explosion in the case of a short circuit or mechanical damage (stepping on a nail). However, a protective circuit is also sensible here since even this type of battery must be protected from overloading or excess currents and total discharge in order to prevent total destruction of the battery.

~~{013}~~[012] Because of its properties, use of lithium-ion polymers would be preferred over the use of the above-described wet cells. It is however disadvantageous that lithium-ion polymers are very expensive.

~~{014}~~[013] Preferably, the rechargeable battery or the rechargeable batteries is or are disposed in the heel region and/or in the foot arch region of the insole.

~~{015}~~[014] The region between the arch of the foot and the toes remains preferably unoccupied. This is particularly advantageous for the rolling movement when walking/running. In this respect, in particular the use of flexible lithium accumulators should be stressed: the wearing comfort of the insole is considerably improved by the flexibility. As a more inexpensive variant, also standard batteries can be used, around which a rigid housing is positively placed for protection.

~~{016}~~[015] Preferably, the heating electrode has Minimelf resistors.

~~{017}~~[016] Minimelfs are electrical miniature resistors with a cylindrical construction, approx. 3 mm long and with a diameter of approx. 1 mm. These resistors are disposed in the sole along bending lines which are present.

~~{018}~~[017] The cylindrical construction and the special arrangement is crucial here. If prismatic SMD resistors were used here, these would immediately

break through the rectangular support surface when subjected to bending of the board.

5       ~~{019}~~[018]       These resistors are connected via  
strip conductors. The strip conductors have a planar  
configuration in order to achieve good heat disper-  
sion from the heating electrode to the foot. Fur-  
thermore, the heating electrode is embedded in a body  
made of plastic material or disposed on said body.  
10       As a result, the required stability is achieved.

15       ~~{020}~~[019]       Preferably, the control circuit is a  
control circuit for continuous regulation of the  
strength of the heating process.

20       ~~{021}~~[020]       With one adjustment switch, one is re-  
stricted to a small number of fixed adjustments of  
the strength of the heating process, the temperature  
can only be altered within rough steps. According to  
the invention, electronic components and software are  
however provided in the control circuit. As a re-  
sult, the size of the steps can be adjusted in a con-  
siderably finer manner relative to an adjustment  
switch. The resolution is adjustable such that a  
25       wearer of the sole can (almost) no longer detect the  
temperature difference between adjacent temperature  
steps. Hence the impression of continuous regulation  
is conveyed.

30       ~~{022}~~[021]       Preferably, the remote control device  
has an external operating part with an actuation ele-  
ment, e.g. a push-button or switch, via which an on  
or off signal is issued to a control part of the re-  
mote control device incorporated in the sole by means  
35       of a transmitter, e.g. an IR transmitter or an ultra-

sonic transmitter, said signal in turn activating or deactivating the heating.

5       ~~{023}~~[022]       In an advantageous manner, the remote control device can also have a contact-free switch, a switch element being disposed in the operating part and a second switch element in the control part.

10       ~~{024}~~[023]       In an advantageous manner, the operating part (10) can have a receiver and the remote control device can be a bi-directional remote control.

15       ~~{025}~~[024]       It must hence be taken into account with a remote control that the signal transmission is partially subject to interference. The object underlying this development is hence to ensure that the operating state of the respective sole corresponds to the settings of the operating part or to the display on the operating part. In other words: defects in  
20       the signal transmission are intended to have no effect as far as possible.

25       ~~{026}~~[025]       The control according to the invention achieves this object in the following manner: the remote control device and the operating part are both equipped with transmitting and receiving units. The remote control device of the respective sole can communicate with the operating part. Via the operating part, the wearer of the sole sets the desired parameter, for example the heat output. This is conveyed  
30       from the operating part to the remote control device of the respective sole.

35       ~~{027}~~[026]       In order to ensure that the signals of the operating part have reached the sole, i.e. that for example the heat output chosen on the operating

part is actually set also by the sole, an acknowledgement of the transmitting signal is provided: the remote control device of the respective sole confirms having obtained the signal from the operating part.

5 If the operating part receives the acknowledgement from both soles, then it is ensured that the selected heat output is present in both soles.

10 ~~{028}~~[027] Further parameters which can be correctly conveyed in this way, are accumulator voltage, temperature of the respective sole and the state of the heating electrode or the heating element, to mention a few examples.

15 ~~{029}~~[028] The functional capability of the operating part can also be monitored with a bi-directional remote control: if the remote control fails for example, then the remote control device detects this by the fact that transmitted signals are  
20 no longer acknowledged. A corresponding reaction can follow thereafter, such as for example lowering of the heat output.

25 ~~{030}~~[029] Furthermore, identification of the respective receiving and transmitting units is provided. It is hence ensured that in the case where a plurality of systems is located in a narrow space, no mutual interference of these systems occurs.

30 ~~{031}~~[030] It is particularly advantageous that a plug contact is incorporated in the sole base body, to which a network device for recharging the accumulators can be connected. However a contact-free recharging of the accumulators, e.g. by induction, can  
35 also be effected.

Brief Description of Drawings

~~{032}~~[031] An embodiment of the present invention is represented in the drawing and is explained in more detail in the subsequent description. There are shown:

~~{033}~~[032] Fig. 1 shows ~~a view on the~~ an exem-  
plary embodiment of an insole according to the pre-  
sent invention, parts of the cover layer being cut  
out,

~~{034}~~[033] Fig. 2 shows ~~a schematic view on the~~  
operating part of the remote control,

~~{035}~~[034] Fig. 3 shows ~~a side view on the~~  
rear part of an insole,  
and

~~{036}~~[035] Fig. 4 ~~shows~~ a schematic view on a  
heating electrode.

Detailed Description

~~{037}~~[036] The insole illustrated in Fig. 1 and Fig. 3 comprises a sole basic body 2 which corresponds for example to an orthopaedic sports insert and can comprise a moulded body or a plurality of layers, and a cover layer 3 which is orientated towards the foot of the user.

~~{038}~~[037] Electronic components are embedded in the sole basic body 2, recesses for two lithium accumulators 4, 5 being provided in the heel region, which can be configured as LI-ion or LI-polymer accumulator cells. Furthermore a preferably encapsulated protective and charging circuit 6 is inserted in the basic body 2, the protective circuit separating the



accumulators from the remaining circuit in the case of a large heat development. The heating electrodes which are disposed in particular in the front foot region under the cover layer 3 over a large area and which comprise resistor faces cannot be seen in the Figure. The heating electrodes are connected to the accumulators 4, 5 via the protective circuit 6. The protective circuit has temperature and current sensors and an intelligent logic which takes over control or disconnection of the heating electrodes. In addition, the lithium accumulators are incorporated in a protective housing in order that the user does not suffer harm in the case of an explosion of the battery. In this case, the pressure wave is absorbed and the heat in the shoe is dispersed downwardly.

~~[039]~~[038] In the illustrated embodiment, the charging circuit 6 is connected to a plug contact 7 which is likewise incorporated in the sole basic body 2 and uncovers its plug elements outwardly. A network device for charging can be connected to this plug contact.

~~[040]~~[039] Furthermore, a remote control 8 in the form of a fitted printed circuit board is inserted in the basic body 2, said printed circuit board being connected to the protective and charging circuit 6 and to the heating electrodes, not shown, and which controls the connection and disconnection of the heating electrodes. The connection lines 9 are shown here above the cover layer 3. Of course, they are likewise inserted underneath the cover layer in the sole basic body. The remote control normally has a transmitting and receiving mechanism which operates with infrared rays or ultrasound or other modulated

radio signals. The frequency ranges can be in the longwave, microwave, HF or UHF range.

5       ~~{041}~~[040]       Furthermore, electronic switch elements are provided which control the voltage supply between accumulators 4, 5 and heating elements. In addition, temperature sensors can be provided which serve likewise for controlling the heating elements.

10       ~~{042}~~[041]       The operating part 10 for the remote control, which can be configured for example as a keyring attachment or the like and is illustrated schematically in Fig. 2, likewise has a transmitting and receiving device which provides signals to the  
15       remote control part 8 in the sole and receives them from the latter. Furthermore, a plurality of display elements 11 is provided which can be configured as LEDs and which display the switching state and/or temperatures. Furthermore, the operating part 10 has  
20       a push-button or push-switch 12 which generates a switch-on or switch-off signal or selection signals for the temperature steps, which is transmitted via the transmitting and receiving mechanism to the remote control part 8 in the sole 1.

25       ~~{043}~~[042]       Furthermore, the control circuit is configured as a "continuous" control. The necessary electronics and software are integrated in the control circuit. The wearer can adjust the temperature  
30       which is most pleasant for him via the operating part 10. The adjustment is actuated via the push-button 12.

35       ~~{044}~~[043]       The control circuit is a control circuit for a pulsating heating process, i.e. heating impulses are emitted at a frequency coordinated to

the blood circulation. Alternatively a constant heating process can also be provided.

5       ~~{045}~~[044]       The remote control of this system of  
sole-operating part has a bi-directional configura-  
tion. The respective received signals are acknowl-  
edged via a response signal. It is hence ensured  
that the receiver has obtained the signal, that for  
example the temperature selected at the operating  
10       part 10 was actually transmitted to the remote con-  
trol device in the soles.

15       ~~{046}~~[045]       Fig. 4 shows a schematic view of a  
heating electrode according to the invention.

20       ~~{047}~~[046]       A board 13 is shown. The board is em-  
bedded in the front region in the sole. It covers  
this front region over a large area. The board com-  
prises epoxy resin and is flexible. As a result the  
flexibility of the sole is also maintained. Alterna-  
tively, other flexible plastic materials or plastic  
material resins can however also be used.

25       ~~{048}~~[047]       The board is almost entirely coated  
with copper. This copper layer is thereby separated  
galvanically into a first region 14 and into a second  
region 15. These two regions are contacted with two  
electrodes 16. Via cable 18 and a plug 19, the elec-  
trodes 16 are connected to the control circuit, not  
30       shown in this Figure.

35       ~~{049}~~[048]       The electrical connection between the  
first region 14 and the second region 15 is produced  
via three cylindrical Minimelf resistors 17 with a  
resistance of 27 ohm and connected in parallel. These  
resistors are soldered directly onto the copper

layer. They are orientated in the longitudinal direction according to the bending lines of the sole.

5       ~~{050}~~[049]       The resistors are disposed on the board in such a manner that they cover respectively as large a region as possible of the board which does not overlap with the region of another resistor.

10       ~~{051}~~[050]       Alternatively, a different number of resistors can also be used. This is dependent inter alia upon the size of the surface which is to be heated.

15       ~~{052}~~[051]       If a voltage is now applied to the electrodes 16, then the resistors 17 are heated. Since these resistors are soldered directly on the regions 14 and 15 of the copper layer, these resistors emit their heat directly to the copper layer. Due to the arrangement of the resistors, large heat  
20       distributions or temperature gradients on the copper layer are prevented. The copper layer distributes the heat rapidly and over a large area.

25       ~~{053}~~[052]       In another embodiment, a contact-free switch can be used for switching on and switching off, which is configured for example as a magnetic switch, proximity switch or the like and in which a first switching element is provided instead of the push-button 12 in the operating part 10 and a second  
30       switching element is disposed in the so-called "remote control" in the sole. In this case, a transmitter can likewise be provided in the sole and a receiver in the operating part 10 in order to transmit information about the starting state and if necessary  
35       temperatures to the display elements 11.

~~{054}~~[053] In yet another embodiment, these display elements can be omitted and the operating part 10 comprises merely the first switching element.

## Patent Claims

1. An electrically heatable insole, comprising:  
5       at least one sole basic body;  
      a cover layer;  
      at least one heating electrode;  
      at least one rechargeable battery electrically  
      connected to the heating electrode; and  
10       a control circuit controlling a heating process  
      and recharging the battery,  
      wherein the heating electrode, the battery and  
      the control circuit are disposed at least one of (i)  
      in the sole basic body and (ii) between the sole ba-  
15       sic body and the cover layer, and  
      wherein the control circuit includes (i) a re-  
      mote control device switching the heating process on  
      and off and (ii) a protective circuit disconnecting  
      the battery in an event of a defect.
- 20       2. The insole according to claim 1, wherein the  
      battery is a lithium accumulator.
- 25       3. The insole according to claim 1, wherein the  
      battery is disposed in at least one of (i) a heel re-  
      gion and (ii) a foot arch region of the insole.
- 30       4. The insole according to claim 1, wherein the  
      heating electrode includes Minimelf resistors.
5. The insole according to claim 1, wherein the  
      control circuit continuously regulates a strength of

the heating process.

5        6. The insole according to claim 1, wherein the remote control device has an external operating part and an incorporated control part.

7.       The insole according to claim 1, wherein the remote control device has a contact-free switch.

10       8. The insole according to claim 1, wherein the remote control device has a transmitting and receiving unit which wirelessly transmits information.

15       9. The insole according to claim 6, wherein the operating part includes display elements for at least one of (i) a functional display and (ii) a temperature display.

20       10. The insole according to claim 6, wherein the operating part has a transmitter and an actuation element which activates the transmitter, the transmitter, in an activated state, transmitting a wireless switch-on signal to the incorporated control part.

25       11. The insole according to claim 8, wherein the operating part has a receiver and the remote control device is a bi-directional remote control.

30       12. The insole according to claim 6, wherein the operating part includes a first switching element of a contact-free switch which cooperates with a second switching element disposed in the incorporated con-

trol part.

13. The insole according to claim 7, wherein the contact-free switch is configured as one of a reed switch, a magnetic switch and a proximity switch.

14. The insole according to claim 1, wherein a plug contact connected to the control circuit for connection of a network device is incorporated in the sole basic body.

~~1. Electrically heatable insole comprising at least at one sole basic body and a cover layer, at least one heating electrode, at least one rechargeable battery which is electrically connected to the heating electrode and also a control circuit for controlling the heating process and for recharging the battery, wherein heating electrode, rechargeable battery and control circuit are disposed in the sole basic body and/or between sole basic body and cover layer, **characterised in that** the control circuit (6, 8) has a remote control device for switching the heating process on and off and a protective circuit for disconnecting the rechargeable battery in the event of a defect.~~

~~2. Insole according to claim 1, **characterised in that** the at least one rechargeable battery (4, 5) is a lithium accumulator.~~

~~3. Insole according to one of the claims 1 to 2, **characterised in that** the rechargeable battery~~



~~or the rechargeable batteries is/are disposed in the heel region and/or in the foot arch region of the insole.~~

- 5        4. ~~Insole according to one of the claims 1 to 3,~~  
           ~~characterised in that the heating electrode has~~  
           ~~Minimelf resistors.~~
  
- 10       5. ~~Insole according to one of the claims 1 to 4,~~  
           ~~characterised in that the control circuit is a~~  
           ~~control circuit for continuous regulation of the~~  
           ~~strength of the heating process~~
  
- 15       6. ~~Insole according to claim 1 to 5, characterised~~  
           ~~in that the remote control device (8) has an ex-~~  
           ~~ternal operating part (10) and an incorporated~~  
           ~~control part.~~
  
- 20       7. ~~Insole according to one of the claims 1 to 6,~~  
           ~~characterised in that the remote control device~~  
           ~~has a contact free switch.~~
  
- 25       8. ~~Insole according to one of the claims 1 to 7,~~  
           ~~characterised in that the remote control device~~  
           ~~has a transmitting and receiving unit for wire-~~  
           ~~less transmission of information.~~
  
- 30       9. ~~Insole according to one of the claims 5 to 8,~~  
           ~~characterised in that the operating part (10)~~  
           ~~has display elements (11) for functional display~~  
           ~~and/or temperature display.~~
  
- 35       10. ~~Insole according to one of the claims 5 to 9,~~  
           ~~characterised in that the operating part (10)~~  
           ~~has a transmitter and an actuation element (12)~~  
           ~~for activating the transmitter which, in the ac-~~

~~tivated state, transmits a wireless switch-on signal to the incorporated control part.~~

5      ~~11. Insole according to one of the claims 8 to 10,~~  
~~characterised in that the operating part (10)~~  
~~has a receiver and in that the remote control~~  
~~device is a bi-directional remote control.~~

10      ~~12. Insole according to one of the claims 5 to 11,~~  
~~characterised in that the operating part (10)~~  
~~has a first switching element of a contact-free~~  
~~switch which cooperates with a second switching~~  
~~element disposed in the incorporated control~~  
~~part.~~

15      ~~13. Insole according to one of the claims 5 to 12,~~  
~~characterised in that the contact-free switch is~~  
~~configured as a reed switch, magnetic switch,~~  
~~proximity switch or the like.~~

20      ~~14. Insole according to one of the claims 5 to 13,~~  
~~characterised in that a plug contact connected~~  
~~to the control circuit (6, 8) for connection of~~  
~~a network device is incorporated in the sole ba-~~  
25      ~~sic body (2).~~

## ABSTRACT

~~The invention relates to a~~An electrically heatable in  
5 sole may include comprising at least one sole base  
body and one covering layer, at least one heating  
electrode, at least one rechargeable battery that is  
electrically connected to the heating electrode, and  
10 a control circuit for controlling the heating process  
and the charging of the battery. ~~According to the in-~~  
~~vention, h~~Heating electrodes, rechargeable batteries  
and a control circuit are arranged in the base body  
of the sole and/or between the base body and the cov-  
ering layer. The control circuit ~~comprises~~ includes a  
15 remote control device for starting and stopping the  
heating process, and a protection circuit for discon-  
necting the rechargeable batteries in the event of an  
error.